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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>6</sup> :</b> <b>C08L 23/12, 53/00</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 98/21275</b> <b>(43) International Publication Date:</b> 22 May 1998 (22.05.98)
<b>(21) International Application Number:</b> PCT/US97/20813 <b>(22) International Filing Date:</b> 13 November 1997 (13.11.97)  <b>(30) Priority Data:</b> 08/748,323 13 November 1996 (13.11.96) US  <b>(71) Applicant:</b> EXXON CHEMICAL PATENTS INC. [US/US]; 5200 Bayway Drive, Baytown, TX 77520-5200 (US).  <b>(72) Inventor:</b> MEKA, Prasadara; 2730 Sandpebble Drive, Seabrook, TX 77586 (US).  <b>(74) Agents:</b> MILLER, Douglas, W. et al.; Exxon Chemical Company, P.O. Box 2149, Baytown, TX 77522-2149 (US).		<b>(81) Designated States:</b> CA, CN, JP, MX, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>
<b>(54) Title:</b> MODIFICATION OF POLYPROPYLENE IMPACT COPOLYMERS WITH METALLOCENE BASED POLYETHYLENES  <b>(57) Abstract</b>  Automotive interior trim parts made from impact copolymer polypropylene, which usually signifies a homopolymer polypropylene with an ethylene, alpha-olefin elastomeric polymer, is blended with very low density linear low density polyethylenes usually known as plastomers. Certain blends of these components will have excellent utility in automotive interior trim parts, providing most importantly, brittle to ductile, preferably ductile failure when tested for impact resistance at -20 °C and 15 mile per hour impact. However, such blends are also preferentially endowed with relatively high melt flow rates, generally above 15 dg/min. and additionally display room temperature notched izod impact strength of 3 ft. lb/in, and a 1 % secant flexural modulus exceeding 140,000 psi. All such properties are achieved, surprisingly and unexpectedly in the substantial absence of reinforcing fillers.		

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**Modification of Polypropylene Impact Copolymers**  
**with Metallocene Based Polyethylenes**

**TECHNICAL FIELD**

5       The present invention relates to automotive interior trim parts, generally including polypropylene, usually an impact copolymer including polypropylene and an ethylene  $\alpha$ -olefin elastomeric polymer, and ethylene  $\alpha$ -olefin copolymers, specifically a plastomer. More specifically, embodiments of the present invention include such parts that fail in a ductile mode, when tested for such failure at 15  
10   mph and at -20 °C.

**BACKGROUND**

      Polypropylene is a commodity plastic having unique properties such as low density, excellent chemical resistance, and stiffness approaching those of  
15   engineering polymers such as ABS, PBT, PET, and the like. However, homopolypropylene generally has poor low temperature impact properties, as it fails in a catastrophic manner at temperatures lower than 0°C. This may be attributed to the glass transition ( $T_g$ ) temperature of polypropylene, which is in the range of -5 to 0°C, below where the polymer usually behaves like a glass, with  
20   low impact strength.

      Over the last 15 years, the automotive industry has sought to lower the weight of automobiles, and improve styling at the same time. This has led to the wide use of various plastics in both interior and exterior parts. In an automotive interior, not only are the aesthetics important, but also the ability of a part to  
25   function for an extended period of time and be relatively easy to fabricate. An important part of function of interior trim parts is low temperature impact resistance, a requirement in cold climates when an auto impacts another solid object or the components inside the automotive are struck with solid objects. The parts should not fail in any mode that could present sharp and or pointed parts, presenting potential safety issues.  
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      In order to improve the performance of polypropylene in such parts, in particular the low temperature impact properties, the polymer industry has modified polypropylene by blending it with ethylene-propylene rubbers, such that the rubber forms a dispersed phase in a polypropylene continuous matrix phase,  
35   thus improving the impact strength, but usually sacrificing stiffness in proportion

to the level of the added rubber phase. Stiffness is important because insufficient stiffness leads to part warpage or sagging.

Over the past 10 years, the polymer industry also began making polypropylene and ethylene-propylene rubber in a continuous process through advances in reactor technology. Such polymers are classified as polypropylene impact copolymers (ICP), as contrasted to compounded polypropylenes (with for instance homopolypropylene and EP or EPDM rubber). The primary applications for these polypropylene impact copolymers are in areas requiring good stiffness and low temperature impact strength. In recent years, the use of these polypropylene impact copolymers has grown into the automotive interior trim and exterior applications at a rapid rate, replacing the engineering polymers such as acrylonitrile-butadiene-styrene (ABS) and in some cases metal components.

Automotive interior trim parts are becoming more complex and larger in size and the molders of these parts are therefore requiring higher flow (melt flow rate or MFR) materials, so that the larger parts may be molded in a lower elapsed time (known as cycle time, and is typically in the order of 50 seconds or less). To satisfy these molder needs, the manufacturers of polypropylene impact copolymers are making higher and higher MFR resins (melt flow rate is generally inversely related to the molecular weight of the polymer, specifically, higher MFR usually means lower molecular weight and vice versa). Working at cross purposes to higher MFR resins, is the sacrifice of room temperature notched izod (RTNI) impact strength. The drop in RTNI is significant above a polypropylene MFR of 6, and at present, the typical MFRs used for automotive interior trim components is 20-35 dg/min and is likely to go higher in the future.

The automotive industry desires ductile failure mode of polypropylene interior trim parts at low temperatures in order to satisfy the stringent specifications requiring head and side impact. In the ductile failure mode, the area of impact only partially opens up, leaving the remainder of the part intact, and more importantly, there are generally no flying pieces of the failed part as is the case under shatter failure mode.

In the automotive industry, the terminology used for polypropylene impact copolymers or other engineering resins is the stiffness-impact balance. Such a stiffness-impact balance implies that good stiffness is required as well as good impact strength, as the polymer industry knows how to make either stiffer or good low temperature impact materials by changing the composition of the rubber phase. But, it is extremely difficult to achieve both good stiffness and good

impact strength without sacrificing one or the other. Even more importantly, it is difficult to achieve at least brittle-ductile failure or preferably ductile failure with materials having good stiffness and impact strength and with higher MFR resins, as mentioned earlier.

- 5           Other solutions to such a difficult balancing act have included adding a polyethylene such as either a polyethylene homopolymer or an ethylene  $\alpha$ -olefin copolymer. Even at higher levels of these modifiers, it is difficult to achieve good low temperature impact in particular at  $< -20^{\circ}\text{C}$ .

10           There is a commercial need therefore for a moldable plastic that can provide the molders of automotive interior trim parts and the automotive manufacturers that use such parts, a part that will fail preferably in ductile mode or brittle to ductile failure mode at 15 mph and  $-20^{\circ}\text{C}$ , will have a relatively high MFR (to facilitate faster molding cycles), all the while maintaining a relatively high stiffness, and an RTNI above 3 ft. lb./in. ( $16 \text{ KJ/m}^2$ ).

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#### SUMMARY

I have discovered that when certain metallocene catalyzed ethylene  $\alpha$ -olefin copolymers (m-ethylene copolymers) are blended with ICP polypropylene, not only can a molded part be formed that exhibits brittle-ductile to completely ductile failure at 15 mph and  $-20^{\circ}\text{C}$ , but stiffness can also be maintained at an excellent level, generally 1% secant modulus greater than 140,000 psi (966 MPa), all while maintaining a MFR above 15 dg/min, an RTNI above 3 ft. lb./in. ( $16 \text{ KJ/m}^2$ ), and a Gardner impact above 300 in-lbs. (34J).

25           In certain embodiments of my invention, a blend composition is described having

- a)       an impact copolymer polypropylene including a homopolymer polypropylene having a MFR of 15-60, and an ethylene propylene rubber, where the rubber contains ethylene in the range of 30-65 weight percent based on the total rubber content. Wherein the rubber is present in the impact copolymer in the range of 4-20 weight percent based on the total weight of the impact copolymer; and
- b)       an ethylene  $\alpha$ -olefin copolymer wherein said  $\alpha$ -olefin has from 4 to 10 carbon atoms, the ethylene  $\alpha$ -olefin copolymer having:
  - i)       a  $M_w/M_n$  below 3

ii) a density in the range of 0.88 - 0.925 g/cc

wherein the ethylene alpha-olefin copolymer is present in the blend in the range of from 5-40% weight percent based on the total weight of the blend; and wherein a plaque injection molded from the blend has a 1% secant flexural modulus of at least 140,000 psi (966 MPa) as measured by ASTM D-790A, wherein the final MFR of the blend is at least 15, and the room temperature notched izod is at least 3 ft lb/in. (16 KJ/m<sup>2</sup>)

Additionally an automotive interior trim component is contemplated having low temperature impact properties at 15 miles per hour at -20° C providing at least ductile failure, comprising a polypropylene, an ethylene alpha-olefin elastomeric polymer; and an ethylene alpha-olefin copolymer wherein said copolymer has an Mw/Mn less than 3, a density from 0.88 - 0.91 g/cc, wherein the elastomeric polymer is present in the component from 4-20 weight percent based on the weight of the impact copolymer, wherein the ethylene alpha-olefin copolymer is present in the component from 10-20 weight percent based on the total weight of the blend; and wherein the component has a 1% secant flexural modulus above 140,000 psi (966 MPa) as measured by ASTM D-790A, where the polypropylene, elastomeric polymer and ethylene copolymer blend will have an MFR of at least 15.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1 shows the effect of final MFR of ICP on the RTNI, for a series of medium impact copolymers.

Figure 2 shows the stiffness-impact balance curve as a function of the EP rubber level in an ICP. The stiffness and impact strength are inversely related to each other.

#### **DETAILED DESCRIPTION**

This invention concerns certain polyolefin polymers combinations or blends, particularly blends of polypropylene ICPs blended with certain m-ethylene copolymers, their conversion into fabricated automotive interior trim articles such as A (front), B (middle), and C (rear) pillars and side panels, and other automotive components requiring better low temperature impact includes front side rail, front and rear headers, front header, sliding door track, etc. Specifically applications in which such trim articles have relatively good low temperature impact properties

combined with good stiffness and relatively high MFR. The blends are particularly well suited for use in producing certain classes of automotive interior trim parts.

Principally these blends and articles made from isotactic polypropylene, an ethylene-propylene rubber phase and an ethylene alpha-olefin copolymer are used in automotive interior trim applications, specifically those applications requiring excellent low temperature impact resistance, good stiffness and relatively high MFR. The resulting molded automotive interior trim parts have combinations of properties rendering them superior and unique compared to previously available automotive interior trim parts previously available.

Following is a detailed description of certain preferred polyolefin compositions, and automotive interior trim parts made from these compositions. Those skilled in the art will appreciate that numerous modifications to these preferred embodiments can be made without departing from the scope of the invention. For example: Though the properties of molded plaques made from polypropylene ICP, m-polyethylene blends, specifically such blends including very low density m-polyethylenes (e.g. 0.86-0.915 g/cc) are exemplified in automotive interior trim applications, they will have numerous other uses such as the vehicle interior trim parts as a part of a vehicle or automobile body and the blends may be formed from other polymer combinations. To the extent that the description below is specific, it is solely for the purpose of illustrating preferred embodiments of this invention and should not be taken as limiting the present invention to these specific embodiments.

#### Definitions and Test Protocols

Property	Units	Definition or Test
Density	g/cm <sup>3</sup>	ASTM D-792
Molecular weight distribution	none	
Tensile at Yield	psi	ASTM-D638
Elongation at Yield	%	ASTM D-638
Secant Modulus (1%)	psi	ASTM D-790A
Gardner Impact at -29°C	in-lbs	ASTM D-3029G
Heat Deflection Temperature	°C	ASTM D-648
Room Temp. Notched Izod	ft-lb/in	ASTM D-256
Un-notched Izod	ft-lb/in	ASTM D-4812-93
Blush Resistance		GM 9302P

**Physical Property Measurements:****Melt Flow Rate (MFR):**

MFR is measured according to ASTM D1238 test method, at 230°C and 2.16 kg load, and is expressed as dg/min or g/ 10 min.

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**Tensile Strength at Yield and Elongation at Yield:**

Tensile strength at yield is measured according to ASTM D638, with a cross head speed of 50.8 mm/min, and a gauge length of 50.8 mm, using an Instron machine. The elongation at yield is also measured according to ASTM  
10 D638, except with a slight modification. ASTM D638 calls for the use of an extensometer for obtaining the true elongation at yield. In all the measurements disclosed herein, the extensometer is not utilized and elongation at yield values tend to be 50-100% higher than the values obtained with an extensometer.

15 **Flexural Modulus:**

The flexural modulus is obtained according to ASTM D790A, with a crosshead speed of 1.27 mm/min (0.05 in/min), and a support span of 50.8 mm, using an Instron machine.

20 **Gardner Impact Strength and Failure Mode:**

The Gardner impact strength was measured according ASTM D3029, Method G, Procedure GC, at -29°C and on 90 mm diameter and 3.175 mm thickness disks. The failure mode is classified as shatter, brittle, and or ductile, based on the nature of the failure type. For example, in shatter failure mode, the  
25 sample under test fractures into multiple pieces (often the number pieces can be 10-15) on impact by the falling weight. In brittle failure, many radial cracks develop from around the impact point, but the radial cracks do not propagate all the way to the outer periphery of the sample, and the pieces are held together. In ductile failure mode, only the sample portion that is impacted pushes out in an  
30 unsymmetrical manner, with a crack on one side, but rough and fibrillar surface is visible on the crack surface. The failure modes of shatter-to-brittle, brittle-to-ductile, are a combination of the two different types of failure modes in the sample. The failure mode of brittle-to-ductile which is between shatter and ductile, where the part shows radial cracks around the area of impact, but the  
35 pieces are held together. Even though the failure modes described above are based on human judgment, rather than a quantitative number from an instrumental



evaluation, the failure modes are very reproducible. An individual trained in the field can classify different materials using the Gardner impact test procedure very accurately.

5    **Heat Deflection Temperature:**

The heat deflection temperature (HDT) is measured according to ASTM D 648, and under a load of 66 psi, using the equipment made by Ceast Corp.,

**Notched and Un-notched Izod Impact Strength:**

10       The room temperature notched izod impact strength (RTNI) is measured according to ASTM D256 test method. The impact strength equipment is made by Empire Technologies Inc.,

The un-notched izod impact strength at -40°C is measured using ASTM D4812-93.

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**Blush Resistance Measurement:**

The blush resistance or also referred to as the stress mark susceptibility of plastic materials is determined on a 3.2 mm thick injection molded plaques, and following the test procedure outlined in the General Motors Engineering Standards (GM9302P). The 3.2 mm thick injection molded plaque is marked with 40 mm squares. The background color was measured on the center of the marked squares using a Hunter Ultrascan Colorimeter connected with a Personal Computer. The injection molded plaques were then impacted in the middle of the marked squares with 20 in-lbs force using Gardner Impact test at room temperature. The impacted samples were then aged for 24 hr, and the color intensity was measured using the Hunter Ultrascan Colorimeter. The blush resistance or the stress mark susceptibility index is obtained by subtracting the background color from the color after impact with 20 in-lbs force, and is expressed as  $\Delta L$ . The lower the number  $\Delta L$ , in comparison to the control sample, indicates that the material is resistant to blushing.

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**Polypropylene Impact Copolymer**

Various ICPs may be used in embodiments of the present invention. In general, the ICPs will have MFRs of the polypropylene homopolymer (determined by the ASTM D1238 technique) in the range of from 15-200, and most preferably from 15-120 dg/min. Ethylene in the ethylene-propylene rubber phase will be

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present in the range of from 25-70 weight percent, preferably from 30 to 65 percent. The EP rubber phase will be present in the ICP in the range of from 4-20 weight percent, preferably from 6-18 weight percent, more preferably from 10-18 weight percent, all based on the total weight of the ICP. The isotactic  
5 homopolypropylene will be present in the molding composition or blend (ICP and plastomer blend) in the range of from 67-88 weight percent, preferably from 68-86 weight percent, more preferably 68-83 weight percent, based on the total weight of the blend. The MFR of the ICP will be in the range of from 15-60, preferably from 15-50, more preferably from 15-35. While the ICP used in all  
10 examples are so-called reactor blends, I also contemplate physical blends of polypropylene and one or more elastomeric polymers of the ethylene  $\alpha$ -olefin type, generally ethylene propylene elastomeric polymers.

#### Plastomer

15 The plastomer may be any of a number of commercially available ethylene,  $\alpha$ -olefin copolymers. This ethylene copolymer has a density in the range of from 0.85-0.925 g/cc, preferably from 0.86-0.910, more preferably in the range of from 0.88-0.91 g/cc. The  $\alpha$ -olefin utilized to make the ethylene  $\alpha$ -olefin copolymer is selected from  
20 one or more of propylene, butene-1, 4-methyl-1-pentene, pentene-1, hexene-1, octene-1 decene-1 and mixtures thereof. Such combinations include, but are not limited to, copolymers such as ethylene propylene; ethylene, butene-1; ethylene, hexene-1; ethylene, pentene-1; ethylene 4-methyl-1-pentene; ethylene, octene-1; ethylene, propylene; butene-1; ethylene, propylene, hexene-1; ethylene propylene,  
25 pentene-1; ethylene propylene, octene-1; ethylene, and the like may be used as the plastomer portion of the polyethylene/filler blend.

Preferred plastomers for use in blending with ICP are ethylene-hexene-1 and ethylene-octene-1, copolymers, most preferred is ethylene hexene-1.

The plastomer may be made by a number of processes, including low  
30 pressure, gas phase, fluidized bed, slurry or solution processes. The catalysts used for the polymerization are generally of the metallocene-alumoxane, metallocene-ionizing activator, or conventional Ziegler-Natta types. Such catalysts are well known. Thus, useful catalysts are those disclosed in EP 1229368, U. S. Patents numbers 5,026,798 and 5,198,401 incorporated herein by reference for purposes of US patent practice.  
35 The plastomer will have a  $M_w/M_n$  less than 3, and a composition distribution breadth index above 50%, preferable, above 60%, more preferable above 65%.

### Combination of ICP and Plastomer

The plastomer may be present in the ICP/plastomer blend in the range of from 5-40 weight percent, preferably in the range of from 10-30 weight percent, more preferably 10-20 weight percent, based on the total weight of the blend. The MFR of the blend will be above 15, preferably above 17 dg/min. A plaque molded from the blend will have a 1% secant modulus exceeding 140,000 psi (966 MPa), preferably above 150,000 psi (1034 MPa), more preferably exceeding 160,000 psi (1103 MPa), a Gardner impact at -29°C exceeding 300 in-lb (34J), preferably exceeding 325 in-lb (37J), more preferably exceeding 350 in-lb (40J), and a RTNI exceeding 3 (15.6), preferably exceeding 4 (21), more preferably exceeding 5 (26), even more preferable exceeding 6 (31), most preferable exceeding 7 ft-lb/in. (36.4 KJ/m<sup>2</sup>).

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### Fillers

The use of fillers in impact copolymer blends is often an important element in attaining the combination of properties described above. It is my intent that the molded parts made from the unique blend described herein, be substantially free of fillers, including reinforcing fillers. By substantially free I intend that the blend compositions described have less than 10 weight percent of such fillers, based on the total weight of the ICP/ethylene copolymer blend, preferably less than 5 weight percent, more preferably less than 3 weight percent.

However, I further intend that the use of well known additives will not be excluded, such as pigments, anti-static materials, mold release additives, and other such components well known to those of ordinary skill in the art.

### Blends:

The blending of polypropylene impact copolymer (ICP) and polyethylenes with different compositions were done on a Reifenhauer single screw extruder having screw diameter of 60 mm and length/diameter (L/D) of 24:1.

One of the considerations for choosing blend components in particular, the type of polyethylene is the transferability of the pellets in pipes to the compounding equipment (extruders). The free flowability and non-stickiness of the polymer pellets is important and one of the considerations used in this invention. All the polyethylenes made using metallocene catalyst systems and

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used in this invention are non-sticky and free flowing and no coating material used for the pellets.

### Examples

#### 5 Injection Molding of ASTM Samples:

The samples for testing were molded on a 75 ton Van Dorn injection molding machine, using a mold with ASTM test specimens (ASTM D3641).

#### Impact Copolymers Used in the Examples:

Sample ID	MFR (dg/min)	EP rubber Level (wt%)	Ethylene in the EP (wt%)	Comments	Trade Name or Grade Name
A	9.5	17.3	60	Non-nucleated	Experimental
B	25	16	50	Non-nucleated	Escorene® PP7485
C	38	15.4	54	Nucleated	Escorene® PP7715E2
D	33	17.4	50	Nucleated	Escorene® AX-03B-E8
E	43	8	41	Nucleated	Escorene® PP7815

## Polyethylenes Used in the Examples:

ID	Type	Density/MI (g/cc)/(dg/m in)	Co- monomer	Catalyst	Trade Name/Source Grade Name
i	HDPE	0.95/8	-	Z/N	Escorene® <sup>1</sup>
ii	HDPE	0.95/4.7	-	Z/N	Escorene®
iii	LLDPE	0.915/3.5	Butene	Metallocene	Experimental
iv	LLDPE	0.915/3.5	Hexene	Metallocene	Exceed® LL301
v	VLDPE	0.9/3.5	Butene	Metallocene	Exact® 3035
vi	VLDPE	0.9/3.5	Butene, Hexene	Metallocene	Exact® 3034
vii	VLDPE	0.9/1.2	Hexene	Metallocene	Exact® 3032
viii	VLDPE	0.895/2.2	Hexene	Metallocene	Exact® 3037
ix	VLDPE	0.895/3.5	Hexene	Metallocene	Exact® 4050
x	VLDPE	0.895/16.5	Hexene	Metallocene	Exact® 4044
xi	VLDPE	0.895/1.6	Octene	Metallocene	Affinity® PF1140 <sup>2</sup>
xii	HDPE	0.95/4.8	-	Z/N	Escorene®
xiii	LLDPE	0.916/1.0	Butene	Z/N	Escorene® LL1001
xiv	LLDPE	0.916/1.0	Hexene	Z/N	Escorene® LL3001
xv	LLDPE	0.9135/1.0	Octene	Z/N	Attane® <sup>2</sup>
xvi	VLDPE	0.885/0.665	Butene	Z/N	Flexomer® DFDA-1085 <sup>3</sup>
xvii	LDPE	0.921/1.0	-	FR/High Pressure	Escorene® LD103

<sup>1</sup> ECA Houston, TX   <sup>2</sup> Dow Chemical Co., Freeport, TX   <sup>3</sup> Union Carbide Corp., Danbury, CT

## Comparative Examples 1-9

5   Examples 1-8 were blends of the following:

Example 1 is a blend of 90 weight percent ICP A with an MFR 9.5 dg/min, containing 17.3 weight percent EP rubber with 60 weight percent ethylene and 10 weight percent PE-iii. Similarly, Example 8 is a blend of 80 weight percent ICP A with an MFR 9.5 dg/min, containing 17.3 weight percent EP rubber with 60 weight percent ethylene and 20 weight percent PE-vi.

Example 9 is a blend of 90 weight percent ICP B with an MFR 25 dg/min, containing 16 weight percent EP rubber with 50 weight percent ethylene and 10 weight percent PE-ix, and Example 19 is a blend of 80 weight percent ICP B with

an MFR 25 dg/min, containing 16 weight percent EP rubber with 50 weight percent ethylene and 20 weight percent PE-vi.

Table 1: PHYSICAL PROPERTIES ON THE BLENDS OF ICP'S AND  
POLYETHYLENES

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C-1 is ICP A, while examples CE-1 to CE-4 represent blends of ICP-A with polyethylenes i and ii (Zeigler\_Natta catalyzed high density polyethylenes), Examples 1-4 are blends of ICP-A with polyethylenes iii and iv Metallocene catalyzed low density polyethylenes). Of interest in this data set is that the HDPE  
10 blends, while meeting the desired Flex Modulus (FM), none of the CE-1 to CE-4 blends fails in either a "brittle-ductile" or "ductile" mode, while on the other hand the Examples 1-4 meet the desired FM and failure mode ("brittle-ductile" or better), none of these examples has either a MFR or a RTNI in the desired range.

Table 1: PHYSICAL PROPERTIES ON THE BLENDS OF ICP'S AND POLYETHYLENES

Composition and Property	C-1	CE-1	CE-2	CE-3	CE-4	EX-1	EX-2	EX-3	EX-4
ICP A (wt%)	100	90	80	90	80	90	80	90	80
Polyethylene (i) (wt%)		10	20						
Polyethylene (ii) (wt%)				10	20				
Polyethylene (iii) (wt%)						10	20		
Polyethylene (iv) (wt%)								10	20
MFR (dg/min)	9.2	8.8	8.7	8.2	7.8	8.2	7.8	8.4	7.7
Tensile at Yield, psi (MPa)	3793 (26)	3985 (27)	4018 (28)	3904 (27)	3879 (27)	3603 (25)	3397 (23)	3617 (25)	3306 (23)
Elongation at Yield, %	11.9	14.9	16.8	16.7	17.4	17.0	19.7	16.8	18.7
1% Sec. Flex Modulus, kpsi (MPa)	178	175	176.3	172.3	170.8	164	149	164	147
1% Tan. Flex Modulus, kpsi (MPa)	(1226)	(1205)	(1216)	(1188)	(1178)	(1131)	(1028)	(1131)	(1014)
Gardner Impact at -29°C, in-lbs (J)	189.8	185	190	184	183.3	175	160	173	158
Failure Mode at -29°C	(1309)	(1276)	(1310)	(1269)	(1264)	(1207)	(1103)	(1193)	(1090)
HDT, °C	179 (20)	214 (24)	286 (32)	242 (27)	320 (36)	286 (32)	317 (36)	235 (27)	275 (31)
RTNI, ft-lbs/in (KJ/m <sup>2</sup> )	S	B-S	B-S	B	B	B-D	D	B-D	B-D
UN at -40°C, ft-lbs/in (KJ/m <sup>2</sup> )	91.4	92	92.7	91.4	89.9	83.2	82.5	85.3	79.5
Blush Resistance (Δ L)	1.71 (9)	1.73 (9)	1.67 (9)	1.59 (8)	1.87 (10)	1.63 (9)	2.05 (11)	1.83 (10)	3.58 (19)
	10.8 (56)	10.8 (56)	9.34 (49)	11.3 (59)	11.1 (58)	9.3 (48)	9.9 (51)	11.2 (58)	10.4 (54)
	4.26	2.71	0.86	2.56	1.1	2.62	0.96	3.37	1.15

Failure Modes: S - Shatter; B - Brittle, and D - Ductile; S-B-D: Shatter-Brittle-Ductile; B-D: Brittle-Ductile

- 14 -

Table 2: PHYSICAL PROPERTIES ON THE BLENDS OF ICPs AND  
POLYETHYLENES

Examples 5-8 represent ICP-A with polyethylenes v and vi, example C-2 is  
5 unblended ICP-B, while CE-5-8 are ICP-B blended with polyethylenes i and ii.  
Examples 5 and 7 have FM and failure modes in the desirable range, the RTNI  
falls short, while with examples 6 and 8, FM is out of the desired area, while  
failure mode and RTNI are in the desirable range. This demonstrates clearly that  
the PE-vi which is based on hexene and butene comonomers is much more  
10 effective in improving the RTNI in comparison to PE-v which is butene  
comonomer based. And the 1% secant flexural modulus for EX-6 is very close to  
our target of 140,000 psi (966 MPa). Examples CE 5-8 have acceptable 1% secant  
flexural modulus, but fails to reach acceptable level of RTNI or the failure mode,  
indicating that the HDPE is preferable for maintaining FM, but is not an effective  
15 modifier for impact strength or failure mode.



Table 2: PHYSICAL PROPERTIES ON THE BLENDS OF ICP'S AND POLYETHYLENES

Composition and Property	EX-5	EX-6	EX-7	EX-8	C-2	CE-5	CE-6	CE-7	CE-8
ICP A (wt%)	90	80	90	80	100	90	80	90	80
ICP B (wt%)						10	20		
Polyethylene (i) (wt%)									
Polyethylene (ii) (wt%)									
Polyethylene (v) (wt%)	10	20						10	20
Polyethylene (vi) (wt%)			10	20					
MFR (dg/min)	8.3	7.6	8.3	7.8	25.1	20.0	18.7	20.1	18.3
Tensile at Yield, psi (MPa)	3529 (24)	3041 (21)	3495 (240)	3112 (21)	3548 (24)	3827 (26)	3879 (27)	3640 (25)	3788 (26)
Elongation at Yield, %	17.1	23.2	16.7	23.1	10.9	14.2	15.6	11.8	14.5
1% Sec. Flex Modulus, kpsi (MPa)	155 (1069)	131 (903)	160.4 (1106)	139 (959)	182.3 (1257)	185 (1276)	179 (1234)	179.3 (1234)	181 (1245)
1% Tan. Flex Modulus, kpsi (MPa)	163.3 (1124)	138 (952)	171 (1179)	148 (1021)	193.8 (1337)	200.4 (1382)	193 (1331)	192 (1317)	196 (1352)
Gardner Impact at -29°C, in-lbs (J)	279.4 (32)	320 (36)	242 (27)	320 (36)	159 (18)	194 (22)	196 (22)	202 (23)	217 (25)
Failure Mode at -29°C	B-D	D	B-D	D	S	B	B	B	B
HDT, °C	83.3	76.1	83	77.6	92.5	91.5	91.7	89	90.3
RTNI, ft-lbs/in (KJ/m <sup>2</sup> )	1.91 (10)	3.87 (20)	2.04 (10.6)	6.07 (32)	1.55 (8)	1.36 (7)	1.43 (7.4)	1.56 (8)	1.4 (7)
UN at -40°C, ft-lbs/in (KJ/m <sup>2</sup> )	9.34 (49)	10.5 (55)	9.2 (48)	11.24 (58)	7.7 (53)	10.2 (53)	8.8 (46)	10.5 (55)	10.2 (53)
Blush Resistance (Δ L)	3.79	1.02	3.84	1.1	4.73	2.87	2.29	4.25	3.49

Failure Modes: S - Shatter; B - Brittle, and D - Ductile; S-B-D: Shatter-Brittle-Ductile; B-D: Brittle-Ductile

- 16 -

Table 3: PHYSICAL PROPERTIES ON THE BLENDS OF ICP'S AND  
POLYETHYLENES

5 Examples CE-9-16 represent blends of ICP-B with varying amounts of polyethylenes xii, xiii, xiv, and xv. While all of these examples show a FM above the desired lower limit, and examples CE-10, CE-12-16 show an acceptable failure mode (B-D), none of these examples show acceptable RTNI. The examples CE-10, CE-12-16, which utilize polyethylenes using traditional Z-N catalyst systems are effective in improving the RTNI significantly.

Table 3: PHYSICAL PROPERTIES ON THE BLENDS OF ICP'S AND POLYETHYLENES

Composition and Property	CE-9	CE-10	CE-11	CE-12	CE-13	CE-14	CE-15	CE-16
ICP B (wt%)	90	80	90	80	90	80	90	80
Polyethylene (xii) (wt%)	10	20						
Polyethylene (xiii) (wt%)			10	20	10	20		
Polyethylene (xiv) (wt%)							10	20
Polyethylene (xv) (wt%)								
MFR (dg/min)	22	18.2	19	14.8	17.31	14	18	14.3
Tensile at Yield, psi (MPa)	3689 (25)	3874 (27)	3201 (22)	3050 (21)	3257 (22)	3107 (21)	3219 (22)	2998 (21)
Elongation at Yield, %	12.9	16.8	11.1	13.3	12.1	15	13	17
1% Sec. Flex Modulus, kpsi (MPa)	167.4 (1154)	165 (1138)	159 (1097)	145 (1000)	156 (1076)	140.2 (967)	155 (1069)	145 (1000)
1% Tan. Flex Modulus, kpsi (MPa)	171 (1179)	169 (1166)	162 (1117)	149 (1028)	159 (1097)	143 (986)	158 (1090)	146 (1007)
Gardner Impact at -29°C, in-lbs (J)	216 (24)	259 (29)	220 (25)	252 (28)	255 (28)	320 (36)	233 (26)	335 (38)
Failure Mode at -29°C	B	B-D	S-B-D	B-D	B-D	B-D	B-D	B-D
HDT, °C	87	95	87	82	86	77	82.4	76.1
RTNL, ft-lbs/in (KJ/m <sup>2</sup> )	1.67 (8.7)	1.51 (8)	2.1 (11)	2.85 (15)	2.5 (13)	2.8 (14.6)	2.44 (12.7)	2.92 (15.2)
UN at -40°C, ft-lbs/in (KJ/m <sup>2</sup> )	11.6 (60.3)	10.3 (54)	12.7 (66)	13.4 (70)	12.0 (62)	12.0 (62)	11.94 (62)	10.9 (57)

Failure Modes: S - Shatter; B - Brittle, and D - Ductile; S-B-D: Shatter-Brittle-Ductile; B-D: Brittle-Ductile

Table 4: PHYSICAL PROPERTIES ON THE BLENDS OF ICP'S AND  
POLYETHYLENES

In Table 4, CE-17 to 20 and EX-9 to EX-11 show blends of ICP-B with  
5 polyethylenes xvi, xvii, and ix at varying weight percents. While all the blends in  
table 4 reach or exceed the minimum desired FM, and CE-17 and 18 meet the  
failure mode minimum, all of the CE blends fail the RTNI. By contrast EX-9 to 11  
have both acceptable FM and failure mode, but EX 9 and 10 do not meet the  
minimum RTNI, only EX-11 meets all three criteria. The example EX-11 shows  
10 unexpected stiffness-impact balance and desirable failure mode in comparison to  
examples CE-10, CE-12-16, where the polyethylenes are based on traditional Z-N  
catalyst systems, while the polyethylene used in EX-11 is a metallocene based and  
hexene comonomer.

Table 4: PHYSICAL PROPERTIES ON THE BLENDS OF ICP'S AND POLYETHYLENES

Composition and Property	CE-17	CE-18	CE-19	CE-20	EX-9	EX-10	EX-11
ICP B (wt%)	90	80	90	80	90	85	80
Polyethylene (xvi) (wt%)	10	20	10	20			
Polyethylene (xvii) (wt%)					10	15	20
Polyethylene (ix) (wt%)							
MFR (dg/min)	19	14.8	17.8	14.2	22	18.4	18
Tensile at Yield, psi (MPa)	3225 (22)	2776 (19)	3226 (22)	2980 (21)	3313 (23)	3206 (220)	3014 (21)
Elongation at Yield, %	12.7	13.3	13	14	14	17	22
1% Sec. Flex Modulus, kpsi (MPa)	132 (910)	135 (931)	144 (993)	145 (993)	163 (1124)	152 (1048)	144 (993)
1% Tan. Flex Modulus, kpsi (MPa)	154 (1062)	158 (1090)	156 (1073)	158 (1090)	165 (1138)	154 (1062)	145 (1000)
Gardner Impact at -29°C, in-lbs (J)	302 (34)	326 (37)	197 (22)	228 (26)	281 (32)	326 (37)	>350 (>40)
Failure Mode at -29°C	B-D	B-D	B	S-B-D	B-D	D	
HDT, °C	88	74	80.2	75	80.3	79	77
RTNI, ft-lbs/in (KJ/m <sup>2</sup> )	2.68 (14)	6.2 (32)	2.29 (12)	2.4 (13)	2.1 (11)	2.76 (14.4)	7.3 (38) NB
UN at -40°C, ft-lbs/in (KJ/m <sup>2</sup> )	14.4 (75)	19.6 (102)	11.5 (60)	11.5 (60)	12.2 (63)	11.2 (58)	12.8 (67)

Failure Modes: S - Shatter; B - Brittle, and D - Ductile; S-B-D: Shatter-Brittle-Ductile; B-D: Brittle-Ductile; NB - No Break

Table 5: PHYSICAL PROPERTIES ON THE BLENDS OF ICP'S AND  
POLYETHYLENES

EX-12 to EX-19 as shown in table 5, blends of ICP-B with varying amounts of polyethylenes iii, iv, v and vi, all of which show acceptable FM, but blends of 10 weight percent polyethylene all fail in failure mode, and RTNI, and 20 weight percent blends EX 13, 15, and 17 fail in RTNI, while only EX-19 meets all criteria. The significance is that the hexene comonomer based polyethylene and made with metallocene catalyst system is much more effective in comparison to butene comonomer based polyethylene made with metallocenes (EX-17). By comparing EX-17 with EX-19, the effect of comonomer choice is the plastomer may be observed. Specifically, EX-17, a butene based copolymer, meets all criteria but RTNI, this is an unexpected and surprising result.

Table 5: PHYSICAL PROPERTIES ON THE BLENDS OF ICP'S AND POLYETHYLENES

Composition and Property	EX-12	EX-13	EX-14	EX-15	EX-16	EX-17	EX-18	EX-19
ICP B (wt%)	90	80	90	80	90	80	90	80
Polyethylene (iii) (wt%)	10	20						
Polyethylene (iv) (wt%)			10	20				
Polyethylene (v) (wt%)					10	20	10	20
Polyethylene (vi) (wt%)								
MFR (dg/min)	19.3	16.5	20.1	17.6	20.8	17.4	19.7	16.9
Tensile at Yield, psi (MPa)	3348 (23)	3260 (22)	3323 (23)	3202 (22)	3251 (22)	3118 (22)	3309 (23)	3069 (22)
Elongation at Yield, %	11.2	16.8	11.3	16.9	11.5	17.4	11.6	17.05
1% Sec. Flex Modulus, kpsi (MPa)	168 (1159)	154 (1062)	173 (1193)	152 (1048)	167 (1152)	147 (1014)	172 (1186)	148 (1021)
1% Tan. Flex Modulus, kpsi (MPa)	177 (1221)	165 (1138)	184 (1269)	162 (1117)	179 (1234)	156 (1076)	181 (1248)	157 (1083)
Gardner Impact at -29°C, in-lbs (J)	179 (20.2)	231 (26)	188 (21)	243 (27)	189 (21)	305 (34)	204 (230)	325 (37)
Failure Mode at -29°C	B	B	B	B-D	B	B-D	B	D
HDT, °C	84.5	79	84.6	79	83.1	78.4	86.1	77.4
RTNI, ft-lbs/in (KJ/m <sup>2</sup> )	1.48 (7.7)	1.47 (7.6)	1.65 (8.6)	1.94 (10)	1.71 (8.9)	1.97 (10.2)	2.02 (10.5)	3.63 (19)
UN at -40°C, ft-lbs/in (KJ/m <sup>2</sup> )	9.2 (48)	7.34 (38)	8.6 (45)	7.7 (40)	9.5 (49)	8.8 (46)	9.0 (47)	8.9 (46.3)
Blush Resistance (Δ L)	5.95	2.79	5.85	3.62	5.72	2.64	6.84	2.2

Failure Modes: S - Shatter; B - Brittle, and D - Ductile; S-B-D: Shatter-Brittle-Ductile; B-D: Brittle-Ductile

**Table 6: PHYSICAL PROPERTIES ON THE BLENDS OF ICP'S AND  
POLYETHYLENES**

5

Table 6 describes ICP-C, blended with polyethylenes vii, viii, ix, and x.  
Only EX-23 meets all criteria.



Table 6: PHYSICAL PROPERTIES ON THE BLENDS OF ICP'S AND POLYETHYLENES

Composition and Property	C-3	EX-20	EX-21	EX-22	EX-23	EX-24	EX-25	EX-26	EX-27
ICP C (wt%)	100	88	80	88	80	88	80	88	80
Polyethylene (vii) (wt%)		12	20						
Polyethylene (viii) (wt%)				12	20				
Polyethylene (ix) (wt%)						12	20	12	20
Polyethylene (x) (wt%)									
MFR (dg/min)	38.5	27.0	22	27.3	22.7	27.2	23.4	29	31
Tensile at Yield, psi (MPa)	4152 (29)	3528 (24)	3294 (23)	3514 (24)	3297 (23)	3459 (24)	3240 (23)	3496 (24)	3271 (23)
Elong. at Yield, %	8.53	8.45	10.12	8.92	11.6	9.33	12.86	10.4	14.2
1% Sec Flex, kpsi (MPa)	209 (1439)	187 (1290)	170 (1172)	184 (1269)	167 (1152)	184 (1269)	165 (1152)	178	156
								(1228)	(1076)
1% Tan Flex, kpsi (MPa)	215 (1483)	194 (1338)	177 (1221)	189 (1303)	172 (1186)	189 (1303)	169 (1166)	182	161
								(1255)	(1103)
Gardner -29°C, in-lbs (J)	162 (18)	234 (26)	338 (38)	259 (29)	320 (36)	257 (29)	323 (36)	269 (30)	302 (34)
Failure Mode at -29°C	S	S-B	B-D	S-B-D	D	S-B	D	S-B-D	D
HDT, °C	109.1	105.8	97	100.5	96	106	99	102	93
RTNI, ft-lbs/in (KJ/m <sup>2</sup> )	1.15 (6.0)	1.81 (9.4)	2.75 (14.3)	1.87 (9.7)	3.2 (17)	1.96 (10.2)	2.56 (13.3)	1.94 (10)	2.7 (14)
UN-40C, ft-lbs/in (KJ/m <sup>2</sup> )	8.9 (46.3)	10 (52)	12.3 (64)	11.6 (60.3)	12.3 (64)	11.3 (59)	11.2 (59)	10.8 (56)	11.2 (58)

Failure Modes: S - Shatter; B - Brittle, and D - Ductile; S-B-D: Shatter-Brittle-Ductile; B-D: Brittle-Ductile

**Table 7: PHYSICAL PROPERTIES ON THE BLENDS OF ICP'S AND  
POLYETHYLENES**

5 Table 7 describes blends of ICP-C and polyethylenes ix, v, and xi. Only EX-33  
with 20 weight percent of polyethylene xi satisfies all criteria. By comparing EX-  
33 with EX-17 (Table 5) the further effect of comonomer may be observed.  
Specifically EX-33 meets all criteria (with octene-1 based copolymer), but does  
not reach the levels of physical properties of EX-19 (hexene-1 based copolymer).

Table 7: PHYSICAL PROPERTIES ON THE BLENDS OF ICP'S AND POLYETHYLENES

Composition and Property	C-3	EX-28	EX-29	EX-30	EX-31	EX-32	EX-33
ICP C (wt%)	100	85	80	85	80	85	80
Polyethylene (ix) (wt%)		15	20				
Polyethylene (v) (wt%)				15	20	15	20
Polyethylene (xi) (wt%)							
MFR (dg/min)	38.5	26.8	25	30.6	24	25	20.7
Tensile at Yield, psi (MPa)	4152 (29)	3524 (24)	3369 (23)	3535 (24)	3403 (23)	3234 (22)	3012 (21)
Elong. at Yield, %	8.53	9.8	12.7	10.2	12.5	9.35	10.75
1% Sec Flex, kpsi (MPa)	209 (1439)	184 (1271)	169 (1166)	185 (1276)	167 (1154)	160 (1104)	147 (1011)
1% Tan Flex, kpsi (MPa)	215 (1483)	193 (1331)	178 (1228)	194 (1341)	173 (1193)	166 (1145)	151 (1041)
Gardner -29°C, in-lbs (J)	162 (18)	272 (31)	>320 (>36)	256 (29)	297 (34)	300 (34)	> 323 (>36)
Failure Mode at -29°C	S	S-B	D	S-B	B-D	S-B-D	B-D
HDT, °C	109.1	99.6	98	99.7	96.3	97.9	92.1
RTNI, ft-lbs/in (KJ/m <sup>2</sup> )	1.15 (6.0)	1.83 (9.5)	2.8 (14.6)	1.76 (9.2)	2.1 (11)	2.83 (14.7)	3.21 (16.7)
UN-40C, ft-lbs/in (KJ/m <sup>2</sup> )	8.9 (46)	11.8 (61)	13 (68)	11.9 (62)	12.0 (62)	20.7 (108)	16.1 (84)

Failure Modes: S - Shatter; B - Brittle, and D - Ductile; S-B-D: Shatter-Brittle-Ductile; B-D: Brittle-Ductile

- 26 -

**Table 8: PHYSICAL PROPERTIES ON THE BLENDS OF ICP'S AND  
POLYETHYLENES**

Table 8 shows blends of ICP-D with polyethylene ix at weight percents ranging  
5 from 5 to 20. Only when the polyethylene level gets above 7.5 weight percent does  
the molded blend meet all the criteria, but at 17 weight percent the FM begins to  
diminish in this system while the RTNI rises to very high levels.

Table 8: PHYSICAL PROPERTIES ON THE BLENDS OF ICP'S AND POLYETHYLENES

Composition and Property	C-4	EX-34	EX-35	EX-36	EX-37	EX-38	EX-39	EX-40	EX-41
ICP D (wt%)	100	95	92.7	90	87	87	85	83	80
Polyethylene (ix)(wt%)		5	7.5	10	13	14	15	17	20
MFR (dg/min)	33	29.7	28.8	28.4	26.0	26.7	25.8	23.4	22.4
Tensile at Yield, psi (MPa)	3746 (26)	3547 (24)	3436 (24)	3349 (23)	3244 (22)	3243 (22)	3199 (22)	2957 (20)	2810 (19)
Elong. at Yield, %	9.7	9.5	9.9	10.6	14.0	14.7	14.1	20.0	23.3
1% Sec Flex, kpsi (MPa)	187 (1290)	175 (1209)	170 (1172)	164 (1131)	157 (1083)	155 (1069)	150 (1034)	135 (930)	126 (869)
1% Tan Flex, kpsi (MPa)	189 (1303)	188 (1297)	180 (1243)	172 (1186)	164 (1131)	162 (1131)	154 (1069)	139 (959)	130 (897)
Gardner -29°C, in-lbs (J)	175 (20)	240 (27)	260 (29)	289 (33)	303 (34)	346 (39)	> 352 (> 40)	340 (38)	334 (38)
Failure Mode at -29°C	S-B	S-B-D	B	B-D	D	D	D	D	D
HDT, °C	105.2	106	104	100	99	97	96	93.4	89.1
RTNI, ft-lbs/in (KJ/m <sup>2</sup> )	1.63 (8.5)	1.73 (9.0)	2.3 (12)	2.72 (14)	3.5 (18.2)	9.4 (49)	10.2 (53)	13.5 (70)	14.2 (74)
						(NB)	(NB)	(NB)	(NB)
UN-40C, ft-lbs/in (KJ/m <sup>2</sup> )	11.2 (58.2)	11.6 (60.3)	11.9 (62)	12.3 (64)	14.2 (74)	15 (78)	13.6 (71)	17 (88)	21.2 (110)

Failure Modes: S - Shatter; B - Brittle, and D - Ductile; S-B-D: Shatter-Brittle-Ductile; B-D: Brittle-Ductile; NB - No Break

- 28 -

Table 9: PHYSICAL PROPERTIES ON THE BLENDS OF ICP'S AND  
POLYETHYLENES

Table 9 shows ICP-E with polyethylene ix at 20-30 wt %. Only EX-44 with 30 % polyethylene shows all criteria met.

5

Table 9: PHYSICAL PROPERTIES ON THE BLENDS OF ICP'S  
AND POLYETHYLENES

Compsition and Property	C-5	EX-42	EX-43	EX-44
ICP E (wt%)	100	80	75	70
Polyethylene (ix) (wt%)		20	25	30
MFR (dg/min)	42.4	27.3	24.3	23.4
Tensile at Yield, psi (MPa)	5013 (35)	4007 (28)	3740 (26)	3493 (24)
Elong. at Yield, %	11.5	14.6	18.0	18
1% Sec Flex, kpsi (MPa)	230 (1586)	178 (1228)	158 (1090)	145 (1003)
1% Tan Flex, kpsi (MPa)	236 (1628)	183 (1265)	165 (1138)	149 (1030)
Gardner -29°C, in-lbs (J)	< 8.0 (< 1)	142 (16)	217 (25)	>320 (>36)
Failure Mode at -29°C	S	S	S-B-D	D
HDT, °C	117.	103.3	91	91
RTNI, ft-lbs/in (KJ/m <sup>2</sup> )	0.95 (5)	2.3 (12)	10 (52)	12.4 (65)
			(NB)	(NB)
UN-40C, ft-lbs/in (KJ/m <sup>2</sup> )	4.3 (22)	8.5 (44)	9.4 (49)	11.8 (61)

10

Failure Modes: S - Shatter; B - Brittle, and D - Ductile; S-B-D: Shatter-Brittle-Ductile; B-D: Brittle-Ductile; NB - No Break

15

While the present invention has been described and illustrated by reference to particular embodiments thereof, it will be appreciated by those of ordinary skill in the art that the invention lends itself to variations not necessarily illustrated herein. For example, it is not beyond the scope of this invention to include additives with the claimed automotive interior parts or to use other methods to form the claimed parts with other. For this reason, then, reference should be made solely to the appended claims for purposes of determining the true scope of the present invention.

20

**CLAIMS****I Claim:**

1. An automotive interior trim part having low temperature impact properties  
5 at 15 miles per hour, at -20° C, providing at least ductile failure, wherein  
said part has a 1% secant flexural modulus above 150,000 psi (1034 MPa),  
as measured by ASTM D-790A, a Gardner impact at -29°C of at least 300  
in-lb. (34J); and a room temperature notched izod impact of at least 3 ft-  
lb/in., preferably at least 4 ft.lb/in (21 KJ/m<sup>2</sup>), more preferably at least 5  
10 ft.lb/in. (26 KJ/m<sup>2</sup>), comprising:
  - a) a polypropylene homopolymer having an MFR in the range of 15-  
200 dg/min;
  - b) an ethylene propylene rubber having ethylene level of 30-65 weight  
15 percent based on the total weight of said rubber, and
  - c) an ethylene alpha-olefin copolymer wherein said copolymer has a  
density from in the range of 0.88 - 0.91 g/cc., preferably wherein  
said ethylene alpha-olefin copolymer comprises ethylene and one  
of hexene-1 or octene-1, preferably wherein said copolymer has an  
20 Mw/Mn less than 3;

wherein said rubber is present in said part from 4-20, preferably 6-18, more  
preferably 10-18 weight percent based on the total weight of the impact  
copolymer.

25 wherein said ethylene alpha-olefin copolymer is present in said part from  
10-30, preferably 10-20 weight percent based on the total weight of said  
blend composition, and  
wherein said part is substantially free of reinforcing filler.

30
2. The interior trim part of claim 1 wherein said part is substantially free of  
reinforcing fillers.
3. A polypropylene impact copolymer, ethylene  $\alpha$ -olefin blend composition  
35 wherein a plaque molded from said composition exhibits at least a brittle-  
ductile failure mode at 15 mph and -20°C has a 1% secant modulus of at

- 30 -

least 140,000 psi (966 MPa), as measured by ASTM D-790A, a room temperature notched izod impact strength of at least 3 ft-lb/in. (16 KJ/m<sup>2</sup>), and a Gardner impact at -29 °C of at least 300 in-lb. (34J), comprising:

- 5           a)     an impact copolymer polypropylene comprising a homopolymer polypropylene having an MFR in the range of 15-60, and comprising an ethylene propylene rubber, wherein the rubber is present in said impact copolymer in the range of 4-20 weight percent based on the total weight of said impact copolymer; and
- 10           b)     an ethylene alpha-olefin copolymer, said ethylene alpha-olefin copolymer having:
- i)      $M_w/M_n$  below 3
- 15           ii)    a density in the range of 0.85 - 0.925 g/cc

wherein said ethylene alpha-olefin copolymer is present in said blend composition in the range of from 5-40 weight percent based on the total weight of said blend composition, wherein said blend composition has a MFR of at least 15 dg/min.

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4.     The blend composition of claim 3 wherein said molded plaque has a RTNI of at least 4 ft.-lb/in. (21 KJ/m<sup>2</sup>), preferably at least 5 ft.-lb/in.(26 KJ/m<sup>2</sup>), and wherein said plaque fails in a ductile mode; and wherein said ethylene alpha-olefin copolymer is present in said blend in the range of from 10-30 weight percent based on the total weight of said blend composition.
- 25
5.     The blend composition of claim 3 wherein said molded plaque has a RTNI of at least 6 ft.-lb/in.(31.2 KJ/m<sup>2</sup>), preferably at least 7 ft.-lb/in.(36 KJ/m<sup>2</sup>), wherein said plaque has a Gardner impact at -29 °C of at least 325 in-lb.(37J), preferably at least 350 in-lb. (40J) wherein said plaque fails in a ductile mode, wherein said ethylene alpha-olefin copolymer is present in said blend in the range of from 10-20 weight percent based on the total weight of said blend composition and wherein said ethylene alpha-olefin copolymer has a density in the range of 0.88-0.91 g/cc.
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- 35

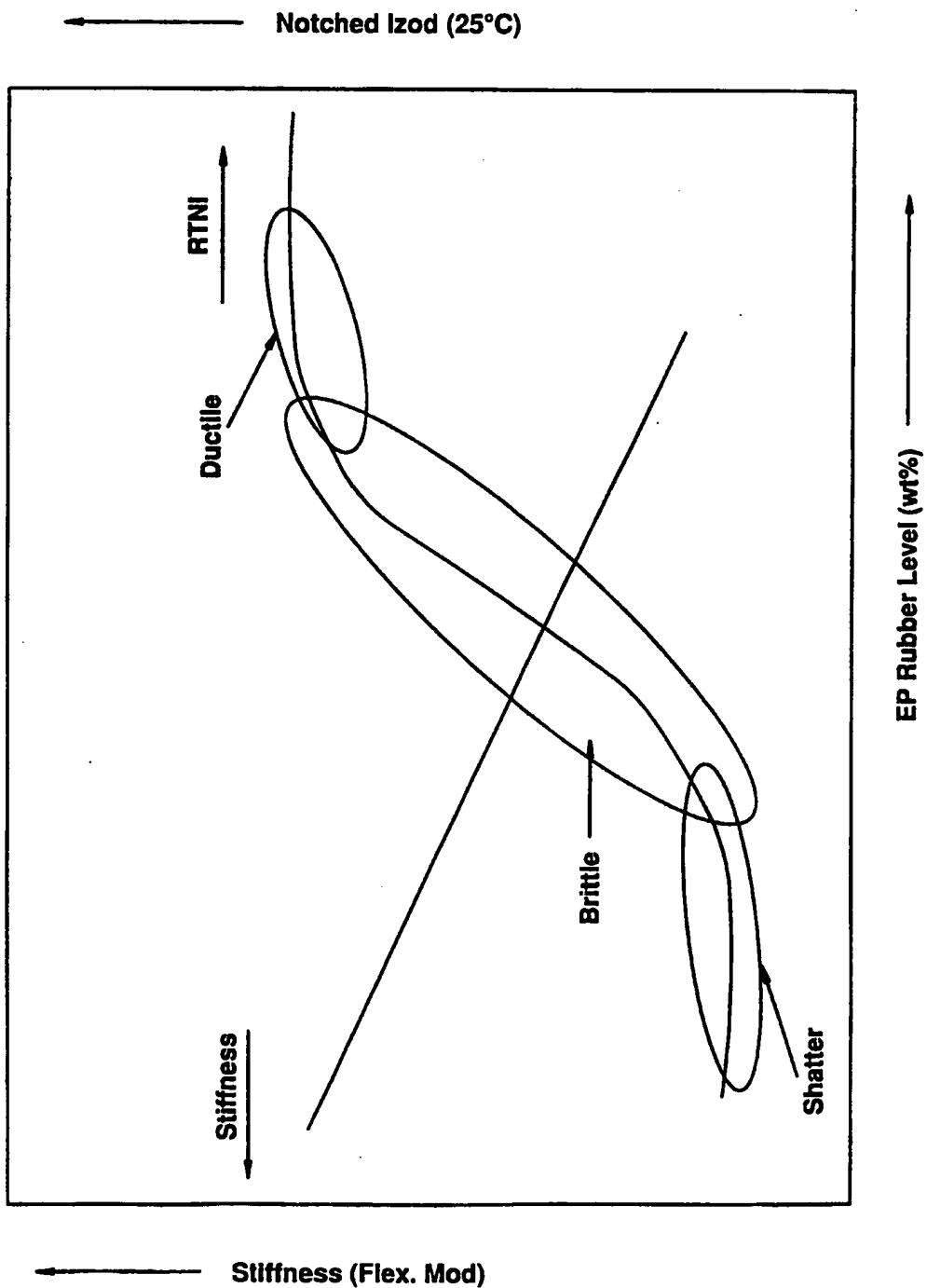


- 31 -

6. The blend composition of any of claims 3, 4, or 5, wherein said blend composition is substantially free of reinforcing fillers.
7. The blend composition of any of claims 3, 4, or 5, wherein in said ethylene-alpha-olefin copolymer, said alpha-olefin is selected from one or more of propylene, butene-1, 4-methyl-1-pentene, pentene-1, hexene-1, octene-1 or decene-1, preferably wherein said alpha-olefin is selected from hexene-1, or octene-1.
8. An automotive interior trim component having low temperature impact properties at 15 miles per hour at -20° C providing at least ductile failure, comprising:
- a) a polypropylene having an MFR in the range of 15-120 dg/min,
  - b) an ethylene propylene rubber including ethylene at a level of 30-65 weight percent based on the total weight of said rubber; and
  - c) an ethylene alpha-olefin copolymer wherein said alpha-olefin has from 4 to 10 carbon atoms, said copolymer having an Mw/Mn less than 3, and a density from 0.88 - 0.91 g/cc.
- wherein said rubber is present in said component from 4-20 weight percent based on the total weight of the impact copolymer,
- wherein said ethylene alpha-olefin copolymer is present in said component from 10-20 weight percent based on the total weight of said component;
- wherein said component has a 1% secant modulus above 150,000 psi (1034 MPa) as measured by ASTM D-790A, a RTNI of at least 6 ft.-lb./in. (31 KJ/m<sup>2</sup>), and a Gardner impact at -29 ° C of at least 300 in-lb. (34J).
9. Use of the automotive interior trim parts of claims 1, 2 or 8, or the blend composition of claims 3, 4, 5, 6, or 7 in an automobile body.

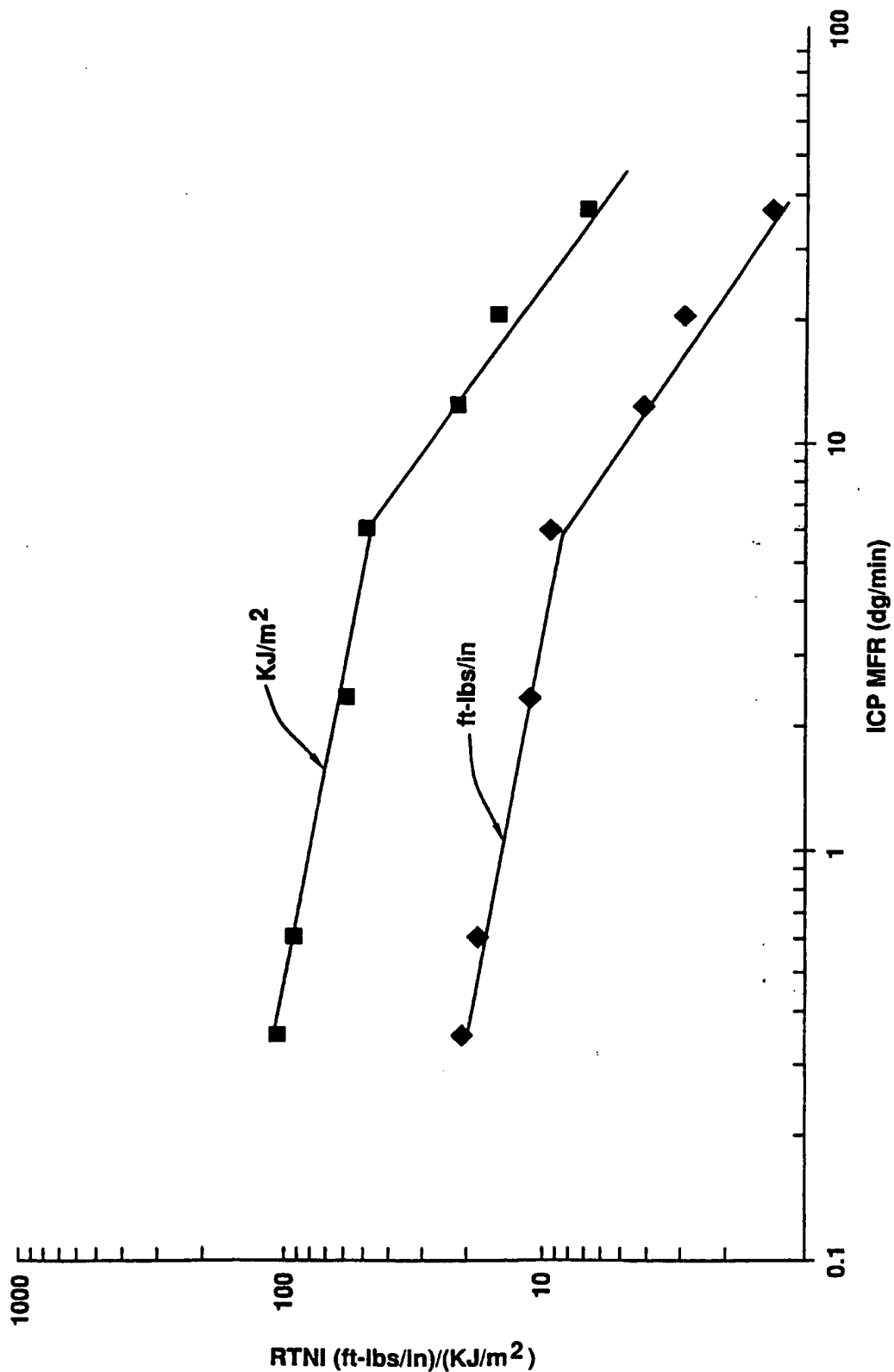
2 / 2

FIG.2



1 / 2

FIG.1



# INTERNATIONAL SEARCH REPORT

Int. l. Application No

PCT/US 97/20813

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 C08L23/12 C08L53/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 C08L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 94 06859 A (DOW CHEMICAL CO ; SILVIS H CRAIG (US); MURRAY DANIEL J (US); FISKE) 31 March 1994 see claims; examples	1-9
A	EP 0 531 054 A (UBE INDUSTRIES) 10 March 1993 see claims	1-9

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

### \* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
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Date of the actual completion of the international search

19 March 1998

Date of mailing of the international search report

31/03/1998

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 97/20813

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